The National Dairy Heifer Evaluation Project: A Profile of Heifer Management Practices in the United States

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ABSTRACT

The National Dairy Heifer Evaluation Project was a cooperative, USDA-sponsored project involving state agricultural departments, the Cooperative Extension Service, the National Agricultural Statistics Service, and the Animal and Plant Health Inspection Service. A series of retrospective and prospective descriptive surveys using a multiple list and area frame sampling technique were conducted. Information collected pertained primarily to dairy neonates and replacement heifers. Much of the study was related to observational information on health and management characteristics that can be related to the animals' long-term physical and economic performance. The data reflect herds representing 78% of the national dairy cow population. Average herd size was 86 milking and dry cows and 66 heifers. Many characteristics of these herds reflect accepted and recommended practices in the area of dairy replacement management and nutrition. Data summarized in this national study can be utilized to evaluate the impact of management practices on dairy operations.

(**Key words**: calf management, heifer management, health, national survey)

Abbreviation key: **NAHMS** = National Animal Health Monitoring System, **NASS** = National Agricultural Statistics Service, **NDHEP** = National Dairy Heifer Evaluation Project.

INTRODUCTION

Epidemiological studies of domestic animals are often conducted to evaluate or to establish possible causal associations between an observed condition and various characteristics of the animals' management and environment (12). These studies also serve as educational tools to help those working with producers address health-related herd problems (11). Additionally, surveys allow teachers and researchers to understand better current management practices and problems on commercial dairies.

The National Animal Health Monitoring System (**NAHMS**) is one program of the Centers for Epidemiology and Animal Health, which includes the surveillance, monitoring, and detection functions of the USDA, Animal and Plant Health Inspection Service, Veterinary Services. The NAHMS program mission is to benefit producers and consumers of animal products by delivering timely, factual information and knowledge about animal health and its interactions with animal welfare, production, product wholesomeness, and the environment.

Several statewide dairy studies were conducted by NAHMS from its inception in 1983 through 1991. Early in the planning for and implementation of the National Dairy Heifer Evaluation Project (**NDHEP**), a Dairy Advisory Group was formed (composed of producers, veterinarians, economists, animal scientists, and animal health regulatory officials) and was responsible for identifying and prioritizing the informational needs of the dairy industry and defining the many possible uses and needs of the data to be collected in the national dairy study (22). Members concluded that the greatest need in the dairy industry was for information about the neonate and replacement heifer. In addition, the advisory group identified the greatest need for

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information as being the interactions of dairy herd management with health and physical and economic performance.

A Dairy Technical Group was then convened to examine the theoretical models to be implemented and data to be collected (23). This Dairy Technical Group was composed of university research and extension personnel in economics, health, and production with specific backgrounds in dairy neonates and replacement heifers.

Dairy calf and heifer management has been previously studied on a limited basis in statewide surveys (5, 7, 13). Other studies have focused on factors that affect calf mortality (3, 6, 9, 10, 13, 19), disease (15), and economics (1). Those studies have had state or regional focuses, and information regarding the national dairy heifer herd has not been available.

A consequence of health problems in calves and heifers may be considerable economic loss, even though specific health problems are not observed (20). Health problems that appear in young stock have been associated with general herd problems (18). Therefore, continued study of herd management and its relationship to animal health is warranted.

The objective of the NDHEP was to establish benchmark data in the form of the health and management of the US dairy calf and heifer population.

MATERIALS AND METHODS

Data collection for the NDHEP was based on a series of prospective and retrospective sample surveys. The basis for these surveys was a probability sample design, which enabled unbiased estimates of herds representing 78% of the US dairy cow population. This design specified that every unit in the population has a known probability of selection (21).

The study design utilized a multiple frame sampling technique designed to combine list and area frames. This multiple frame approach is one of the primary estimation methods used by the USDA National Agricultural Statistics Service (NASS) to generate livestock statistics (21). The NASS list frame is a listing of all agricultural producers in the US. Because of producer transition in and out of business, an area frame or census of all producers from randomly selected local land areas in the US is used to adjust for the incompleteness of the list frames. The estimation model used in this study, containing list and area frames, was as follows: $X = Xa + pXa1 + qX'a1$, where Xa = estimated total of the population not on the list frame estimated from the area frame, $Xa1$ = estimated total of the population included in both frames estimated from the area frame, and $X'a1$ = estimated total of the population included in both frames estimated from the list frame. This method creates the highest likelihood that virtually every dairy herd in the US will have a known probability of being selected.

The NASS model sets $p = 0$, and therefore $q = 1$ (i.e., if an operation is on the list, it is represented by the list frame estimate). This model is often referred to as the screening estimator, which includes the area estimate of list incompleteness plus the list estimate. This estimator is deemed to be most efficient for a given input and yields more precise estimates for livestock than do other area frame estimators (4). The NASS list and area sampling frames used for this study were based on the sampling, data collection, and estimation activities of NASS using the multiple frame model technique. The NASS list stratification for dairy cattle is based on approximate herd size characteristics (milking cow inventories). Strata or size groupings vary by state in accordance with the size characteristics of the dairy farms in each state represented in the survey.

Eighteen states were actively involved in the NAHMS program prior to the dairy study, and additional states were added based on their interest in the study and large populations of dairy cows. A total of 28 states were involved in the study, accounting for 83% of the dairy cows and 68% of the operations with dairy cows in the US based on the NASS data from January 1, 1991. Total sample size of herds was determined by a combination of estimation of preweaning mortality, using an advance prevalence estimate of 6%, budget constraints, and expected response rates. The total sample size targeted for selection was approximately 3300 herds. The total sample was roughly distributed to individual states based on proportion of milk cows in the state relative to the total milk cows in the 28 states (Table 1). Design strata were created by using the existing NASS strata from which operations were

TABLE 1. Percentage of contribution of 28 states in the National Dairy Heifer Evaluation Project.

State	National population[1]	Respondent herds in study	
	(%)	(no.)	(%)
WI	21.87	195	10.8
CA	10.56	145	8.0
MN	9.52	131	7.2
PA	9.07	159	8.8
NY	9.03	172	9.5
OH	4.93	77	4.3
MI	4.31	64	3.6
IA	4.16	64	3.6
TN	2.55	47	2.6
WA	2.47	73	4.0
IN	2.43	57	3.1
IL	2.27	54	3.0
VA	2.09	68	3.8
ID	2.03	52	2.9
New England[2]			
VT	1.79	46	2.5
ME	.55	8	.4
CT	.37	11	.6
MA	.36	8	.4
NH	.26	9	.5
RI	.03	1	.1
NE	1.50	51	2.8
FL	1.31	28	1.5
NC	1.31	47	2.6
OR	1.28	54	3.0
MD	1.23	49	2.7
GA	1.21	44	2.4
CO	.95	49	2.7
AL	.57	47	2.6
Total	100.00	1811	100.0

[1]Percentage is the mean of the percentages of milk cows, replacement heifers, and operations with milk cows of the population for the states included in the study.

[2]New England states were run as a single National Animal Health Monitoring System area, although listed separately herein.

selected and included three milk cow list frame strata (small, medium, and large), which were not uniform across states; an area frame stratum; and a heifer ranch stratum (heifer ranch is best defined using NASS data as 0 milk cows, 0 beef cows, 0 replacement heifers ≥225 kg, and ≥50 calves <225 kg). Operations other than heifer ranches were selected using a minimum of 30 milk cows per herd. Operations from the list strata were selected with increasing probability as herd size increased; heifer ranches were selected with certainty.

Surveys used for data collection throughout the NDHEP were pretested on a limited sample in New York, Maryland, and Virginia and were subsequently modified. The pretest used herds of various sizes to represent small, medium, and large herds for that state. Additional testing of certain components were conducted on several farms in Colorado before implementation.

Initial farm contact and data collection for the NDHEP were performed by NASS enumerators who were given a 1-d training on the scope and conduct of the survey to be administered. Many enumerators were experienced in administering surveys, including other NAHMS studies. Uniform training materials were developed and used in the training sessions held by the individual state survey statisticians and the state NAHMS coordinators.

The first of the questionnaires, the General Dairy Report, was administered by NASS enumerators. This survey focused on dairy herd management practices specific to preweaned heifers. Names of producers willing to participate in the remainder of the study were compiled in each state NASS office and then forwarded to the state NAHMS coordinator. State NAHMS coordinators validated the surveys and then sent the surveys and data to NAHMS staff for final data validation and analysis.

The follow-up subsampling portion of the NDHEP was designed to obtain biological information about the nation's dairy calf population and more detailed retrospective and prospective data on health, nutrition, and management over a 3-mo period on each operation. The 3-mo monitoring periods covering 1 yr represented one annual cycle of the dairy industry. Data were collected by state and federal veterinary medical officers. Only data from the initial surveys are reported herein.

The probability sample design utilized was such that inferences could be made for the population of producers and dairy animals. Because the design involved two stages of sample selection, the NASS estimating program and the NAHMS program as a subsample of the NASS sample, probabilities of selection were to be accounted for in each stage. Therefore, all data collected were weighted to derive population estimates. In the simplest case, the weight for a particular operation was the number of producers within a stratum from

which the producer was selected (eligibles) divided by the number of respondent producers from that stratum. Then, nonresponse adjustments were performed by season, region, and herd size to eliminate biases resulting from major differences between respondents and nonrespondents (21).

Population estimates of the data were obtained using SAS (16) with standard deviations for the population estimates derived using SUDAAN (14), a program specifically designed for multistage survey data analysis. Nonresponse analysis was performed using data from the January 1, 1991 NASS Agricultural Survey.

RESULTS AND DISCUSSION

Starting March 1991, the NASS enumerators contacted groups representing approximately one-fourth of the total sample of herds over 2 to 4 wk at the beginning of each quarter of the study. Subsequent groups were contacted in June, September, and December 1991. The NDHEP is therefore a subsample of the NASS cattle survey from January 1, 1991. The final data set developed from the 12 mo of data collection contained a general information survey from 1811 dairy herds located in 28 states (Table 1). The resulting information represents population estimates for 78% of the national dairy cow population.

A comparison of survey respondents with the total eligible sample size is shown in Table 2. Nonresponse differences were analyzed in a variety of categories. The weighing process explicitly accounted for sample differences in season, region, and herd size, thereby removing response bias in the estimates resulting from these factors.

The primary breed of dairy cattle (Table 3) was Holstein for 94.9% and Jersey for 2.4% of the operations. Other breeds each constituted ≤1%. Proportion of herds with no registered dairy cattle was 59.7%; another 19.7% had ≤25% of their herd registered. The DHI record-keeping systems were used by 57.5% (±1.8) of producers in this study. Overall herd average for milk yield was 7592 kg; 54% of producers used calculated information. Verification was performed using milk shipment receipts and cow numbers. Over 90% of the operations were Grade A milk producers (Table 3). Operations that were not Grade A or B included contract heifer raisers. Data on the average length of the dry period, calving interval, age at first calving, and weight at first calving were provided by the producers at the time of the survey when not available from record-keeping sources. These data, therefore, likely reflect the perceived goals of the operations and not necessarily the actual situation.

A summary of dairy heifers sold or leased is shown in Table 4. A small portion (1.9%) of the operations sold or removed all heifers within 24 h; however, a larger portion sold some heifers before weaning for herd replacements (10.0%) or veal and other reasons (13.9%). Contract heifer raising was used by a very small percentage of the operations (1.6%), despite possible economic benefits predicted (24). Data from the ages that calves were removed from the operation on a contract basis and according to the length of time in the contract operation reveal that most calves re-

TABLE 2. Response rates from the General Dairy Report of the National Dairy Heifer Evaluation Project.

Item	Total eligible sample	Response rate	
		(n)	(%)
Total	3204	1811[1]	56.5
		1984[2]	61.9
Region			
West	696	472	67.8
Midwest	1248	702	56.3
Northeast	677	451	66.6
Southeast	583	359	61.6
Calves per operation, no.			
0–49	1425	820	57.5
>50	1779	1164	65.5
Cows per operation (lactating and dry), no.			
0–99	1762	1055	59.9
>100	1442	929	64.4
Milk production,[3] kg/d			
.5–22.7	1321	767	58.1
>22.8	1624	1043	64.2

[1]Total respondent operations with dairy heifer calves.

[2]Total respondent operations including those with no preweaned heifer calves at the time of herd visit and none expected during the next 3 mo.

[3]Totals do not add to 3204 eligible observations because of missing observations.

TABLE 3. Characteristics of dairy herds surveyed for the National Dairy Heifer Evaluation Project.

Characteristics	(%)	SE
Breed[1]		
Holstein	94.9	.7
Jersey	2.4	.4
Ayrshire	.6	.3
Brown Swiss	1.0	.4
Guernsey	.9	.3
Herd registered, %		
0	59.7	.1
1–25	19.7	.1
26–50	7.4	.1
51–75	3.2	.1
76–99	4.2	.1
100	5.9	.1
Type of dairy operation[2]		
Grade A	90.7	1.2
Grade B	9.0	1.2
	$\bar{X}$	SE
Current rolling herd average		
Milk production,[3] kg	7592	44
Length of dry period, d	61.1	.5
Average calving interval, mo	12.8	<.1
Average age at first calving, mo	25.9	.1
Average weight at first calving, kg	504	2

[1]Totals do not add to 100% because of crossbreeds and other breeds.

[2]Totals do not add to 100% because of contract heifer ranches and other categories.

[3]Current herd average milking production from the Dairy Herd Improvement Association or equivalent value.

TABLE 4. Summary of dairy heifers sold or leased on a contract basis in the National Dairy Heifer Evaluation Project.

Item	$\bar{X}$	SE
Sell or remove all heifers within 24 h, %	1.9	.4
Sell heifers before weaning for replacements, %	10.0	1.0
Sell for veal or other purpose, %	13.9	1.3
Contract raising utilized (total), %	1.6	.3
Newborn to 4 mo, %	.7	.2
4 mo to breeding age, %	.8	.2
Breeding age to calving, %	.2	.1
Average age when contracted		
Newborn to 4 mo, d	31.4	9.6
4 mo to breeding age, mo	9.3	1.4
Breeding age to calving, mo	14.5	.6
Length out to contract herd		
Newborn to 4 mo, mo	16.0	1.8
4 mo to breeding age, mo	13.7	1.3
Breeding age to calving, mo	9.6	.8

mained in the contract herd until near calving, regardless of the age at which the calf was contracted out. More operations that use contracting for heifers were in the West (West, 7.8%; Midwest, .5%; Southeast, 2.1%; and Northeast, 2.4%).

Information pertaining to the normal care and feeding of newborn calves on operations is provided in Table 5. Many calves (67.6%) were removed from their dams within the first 12 h. To receive first colostrum, a great majority of calves received some form of assisted nursing, were hand fed from a bottle or bucket, or were fed through an esophageal feeder. These percentages are similar to those shown previously (7) and reflect a continued interest across the US in improving passive antibody transfer. All methods of colostrum feeding, except unassisted nursing, have the potential to provide the calf with enough first colostrum to supply adequate nutrients and Ig, provided that the source is adequate (15). The source of this colostrum was primarily the dam; pooled colostrum was used by only 3.2% of the herds. Calves receiving ≤1.9 L did not likely receive adequate colostrum, based on Ig concentrations of Holstein cattle (17). Calves receiving >1.9 but <3.8 L also may not have received adequate Ig.

Types of liquids fed before weaning and information regarding weaning practices are given in Table 6. Milk replacer, milk from cows that have just calved, whole milk, and mastitic or antibiotic milk were the types of liquids most often fed. Many producers used a combination of two or more types of liquid feed. With care, milk from mastitic cows or containing antibiotics, milk from cows that have just calved, and fermented colostrum can be efficient and inexpensive sources of calf feed, provided that proper management is used to maintain calves on consistent amounts of daily nutrients (2, 8). Use of milk replacer or whole milk facilitates constant nutrient intakes over time; fewer daily fluctuations are due to management decisions or dilution differences. Ages at which calves were offered grain, forage, and water were similar to those found earlier (5) and show that most operations offered grain early: 88.6% within the first 2 wk of age and 94.8% by 4 wk. However, 1.4%

TABLE 5. Care and feeding of newborn calves from the National Dairy Heifer Evaluation Project.

Item	(% of Operations)	SE
Age separated from dam, h		
0	28.0	1.7
<12	39.6	1.7
12–24	22.0	1.4
>24	10.4	1.0
Method of colostrum feeding		
Nursing		
Assisted	13.8	1.2
Unassisted	19.9	1.4
Hand fed from bucket or bottle	64.0	1.7
Hand fed from esophageal feeder	2.3	.5
No colostrum fed	0	. . .
Source of colostrum		
Dam's first milk	94.6	.7
Pooled excluding first lactation cows	2.3	.4
Pooled including first lactation cows	.9	.3
Stored	1.9	.5
Commercial colostrum substitute	.3	.2
Amount of colostrum in 1st 24 h[1]		
≤1.9	25.6	1.8
>1.9 but <3.8	48.9	2.1
>3.8	26.1	1.9

[1]Holstein farms only.

were not fed grain until ≥8 wk, which was later than the average weaning age (Figure 1). First feeding of hay or other forage was somewhat later: 67.3% of producers fed calves some forage by 4 wk of age, but 12.7% of the producers did not feed forage before calves were 8 wk old. Fewer producers offered water for free choice consumption to young calves at 4 and 8 wk (60.9 and 79.8%) than fed forage and grain at those ages. In this survey of producers, heifer weaning time was largely determined by age, despite other factors related to grain energy intake, as is often recommended (2, 8).

The age at which calves were first grouped is consistent with average age at weaning, showing that calves were generally grouped at weaning. Producers tended to group calves into small groups (7.5 calves), as is recommended (2, 8). On 95% of the operations, calves were dehorned at an average age of 4.1 mo. Removal of extra teats was performed by over one-half of the producers and tended to be performed at a later age (19.1 wk). This age

TABLE 6. Calf management practices on farms from the National Dairy Heifer Evaluation Project.

Item	$\bar{X}$	SE
Types of liquid feeds used, % of total		
Fresh cow milk	51.9	1.8
Whole milk	32.7	1.7
Mastitic or antibiotic milk	37.7	1.7
Milk replacer	59.0	1.8
Fermented milk	3.3	0.6
Other	1.5	0.4
Age calves offered		
Grain, d	9.7	.4
Roughages, d	23.0	.7
Free choice water, d	25.8	.9
Factors determining weaning age, % of total		
Age	43.0	1.8
Weight	26.4	1.6
Grain intake	26.9	1.5
Other	3.7	.6
Average age at weaning, wk	7.9	.1
Percentage of operations that group calves	79.8	1.4
Average age when first grouped, wk	7.8	.2
Average weight when first grouped, kg	86.7	1.1
Average weaned calves in first group, no.	7.5	.1
Percentage of operations that remove extra teats	53.3	1.8
Average age extra teats removed, wk	19.1	.4
Percentage of operations that dehorn heifer calves	95.2	.8
Average age dehorned, mo	4.1	.1
Primary method of horn removal, %		
Caustic paste	7.4	1.0
Electric dehorner	35.0	1.7
Scoop, cut, or gouge	45.3	1.8
Saw	10.5	1.2
Other	1.8	.4
Most common type of identification used, %		
Ear tags	80.5	1.6
Collars	1.3	.4
Photographs or sketches	4.7	.9
Freeze branding	.9	.3
Other branding	.6	.2
Tattoo	2.6	.5
Other	2.1	.5
No identification used	7.3	1.2

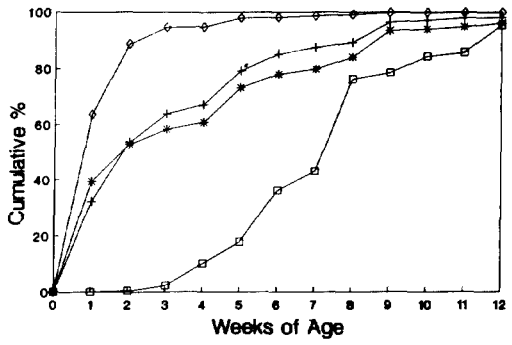

Figure 1. Cumulative percentage of producers that wean calves (□) and first offer grain (◊), forage (+), and water (*) by week of age.

may be associated with other management practices, such as vaccination or moving of calves to another group after the first post-weaning group. Cumulative percentages of several management practices (grouping, dehorning, and removal of extra teats) performed by month of age are shown in Figure 2.

The most common methods of horn removal were electric dehorners and scooping, cutting, or gouging. This result shows little change over past regional surveys. Ear tags were the primary type of visual identification used. For a small percentage of herds (7.3%), no formal identification system was used.

Following this initial survey, producers at dairy operations were given the opportunity to participate in a 3-mo daily data monitoring system. These data will be used in future analyses to study the impact of management on health of US dairy operations.

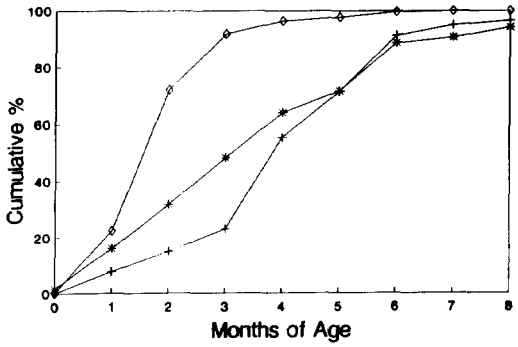

Figure 2. Cumulative percentage of producers that group calves (◊), dehorn (+), and remove extra teats (*) by month of age.

CONCLUSIONS

This study depicts general herd size and dairy replacement management characteristics of farm operations constituting 78% of the US dairy cow population and calf raising operations. These dairy operations throughout 28 states followed many of the accepted and recommended practices in calf and heifer management. Several aspects of dairy farm management needed improvement, such as the amount and methods of first colostrum feeding.

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